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Ocular Patterns as Indices of Intellectual Acheivement

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OCULAR PATTERNS AS INDICES OF INTELLECTUAL ACHIEVEMENT

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Since the days of Ebbinghaus, 1885, who made one of the first real attempts to apply scientific methods to evaluate the problem of learning as related to higher mental processes, innumerable experiments have been made in this field. Based upon such findings, various theories of the learning process have been evolved and formulated, and explanations of the mechanical aspect of learning have been attempted. Each experiment was in a way an attempt to provide information for modern pedagogs to minimize teaching efforts and increase the efficiency of the learner.

PURPOSE OF THIS STUDY

The purpose of this study is to evaluate, by means of ocular photography, the indices of the learning process. Since the mind is known by behavior of some kind, it would seem logical to assume a study of the characteristic behavior of the human eye would reveal some of the mental processes involved. If attention, retention, reason and reproduction are different phases of the learning process, it is likely that the analysis of ocular patterns would provide a valuable technique to evaluate such mental content.

This study is an attempt to evaluate:

1. The relative time spent on respective symbols due to position.
2. The relative achievement of certain symbols due to position.
3. The relative excursion frequency in the vertical and horizontal plane.
4. Characteristic differences of the ocular patterns of subjects of high and low achievements.

METHOD AND PROCEDURE

Exposure Cards: Two cards 14 inches square were constructed with four designs each. All symbols or designs were different, and each covered an area of 4 inches square. Card B was identical to Card A, except that all symbols were reversed in order of position. See Fig. 1.

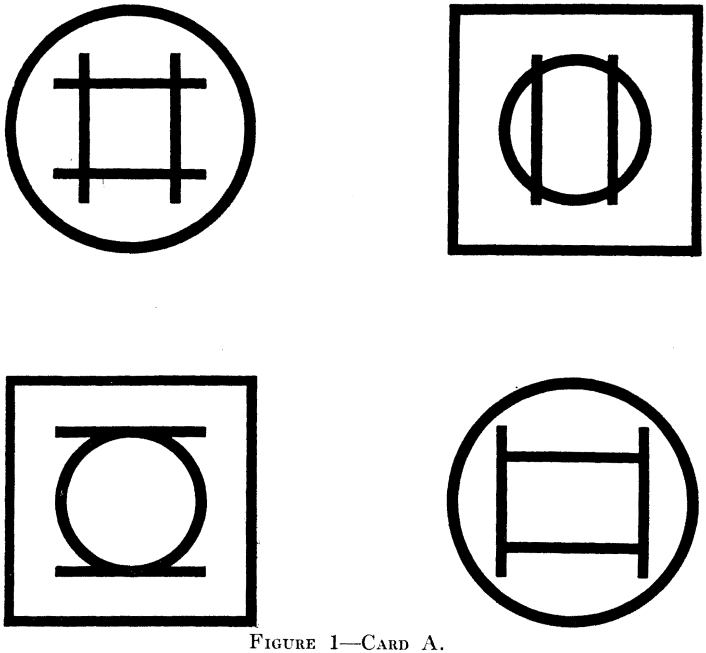

FIGURE 1—CARD A.

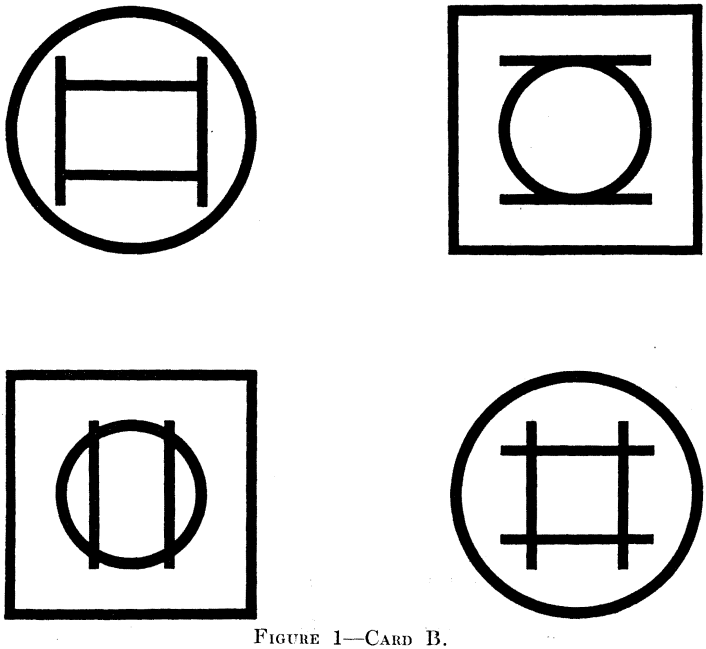

FIGURE 1—CARD B.

Figure 1 Exposure cards A and B; the symbols on Exposure Card A are identified as (1) upper left (2) lower left (3) upper right (4) lower right. Card B (1) lower right (2) upper right (3) lower left and (4) upper left.

Fig. 2. A Bidimensional Eye-movement Camera and Exposure Card; the monofilm Camera was invented and developed by the author of this study. Patent rights have been issued by the U. S. A. Patent Office.

Subjects: Ninety (90) High School seniors selected at random acted as subjects for this study. Forty-five (45) subjects observed card A while forty-five (45) saw card B. Each subject was instructed to observe the card with the intention to reproduce the symbols later. No student was informed of the time limit, but each card was exposed for ten seconds only. If all symbols were correctly reproduced in the proper location, the achievement was 12 units, the highest score obtainable.

Apparatus: A portable bidimensional intermittent monofilm camera was employed to record the ocular pattern of the subjects.

Results

1. *Position and Attention Time:* This study shows that consistently more time is spent on symbols appearing in the upper left position than when appearing in the lower right area.

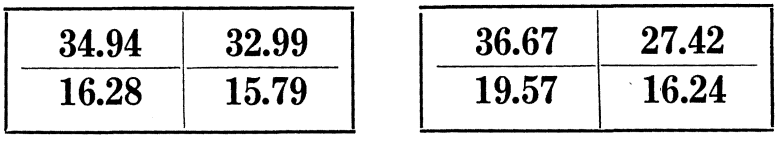

Fig. 3. Relative time in percent devoted to respective symbols of exposure Cards A and B.

For purpose of illustration, only symbols (1) and (4) will be treated statistically. Table I indicates that significantly more time is spent on symbols (1) and (4) in the upper left than when appearing in the lower right position.

Table I. Relative Total Fixation Time Devoted to the Upper Left and Lower Right Hand Position for Symbols (1) and (4)

Symbol	Card	Position	M	S.E.	M diff	S.E. diff	C.R.
1	A	Upper left	3.49	.15			
					1.86	.18	10.33
1	B	Lower right	1.63	.11			

Symbol	Card	Position	M	S.E.	M diff	S.E. diff	C.R.
4	B	Upper left	3.67	.17			
					2.09	.21	9.95
4	A	Lower right	1.58	.12			

This study confirms the findings of an earlier study, namely, that position is a potent determiner of attention values.[1]

2. *Position and Achievement:* By analyzing the ocular patterns of subjects observing the four designs, it is evident that certain positions demand a longer time than others. Just what mental accomplishment took place during that time is illustrated in Fig. 4. This tabulation indicates that the achievement in the upper left hand area is greater than in the lower right hand position.

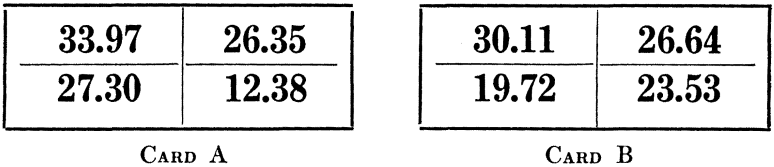

Fig. 4. Percent of total achievement in respective areas of exposure cards A and B.

I. H. F. Brandt *Ocular Patterns and Their Psychological Implications.* Am. Journal of Psychology Vol. 53, No. 2, April 1940, pp. 260-268.

Table II. Relative Achievement for the Upper Left and Lower Right Hand Position for Symbols (1) and (4).

Symbol	Card	Position	M	S.E.	M diff	S.E. diff	C.R.
1	A	Upper left	2.38	.15			
					.87	.23	3.79
1	B	Lower right	1.51	.18			

Symbol	Card	Position	M	S.E.	M diff	S.E. diff	C.R.
4	B	Lower right	.87	.13			
					1.06	.20	5.30
4	A	Upper left	1.93	.15			

Table II supports the assumption that a longer time devoted to study in certain areas (other things being equal) will yield a greater achievement. Both time and achievement are significantly greater for the two symbols when appearing in the upper right hand position. Symbol (4) with a critical ratio of 5.30 seems to profit more from the changed position, than symbol (1) with a critical ratio of 3.78.

3. *Horizontal vs. Vertical Excursions:* A further query presented itself in regard to the character of the excursions of the ocular patterns resulting from the observation of the specified subject matter. Is the excursion frequency greater in the horizontal than in the vertical plane?

In tabulating every excursion of all the subjects the data reveal that a total of (395) excursions from one symbol to another were horizontal movements, (204) were vertical movements and (112) were diagonal excursions.

Table III. Horizontal vs. Vertical Excursion Frequency

Exposure	Excursion	M	S.E.	M diff	S.E. diff	C.R.
Card A	Horizontal	4.73	.30			
				2.69	.39	6.90
	Vertical	2.04	.26			

Exposure	Excursion					
Card B	Horizontal	4.04	.26			
				1.55	.36	4.31
	Vertical	2.49	.20			

The difference in the frequency of the horizontal to vertical movements in observing the symbols is in the ratio of about 2:1, while the vertical to diagonal is in the same ratio. The correlation co-efficients between excursion frequency and excursion distance

to fixation time are .95 and .92 respectively. This close relationship between three measures of ocular performance implies that if a specific time is spent in an area the frequency and distance of excursion will vary proportionally.

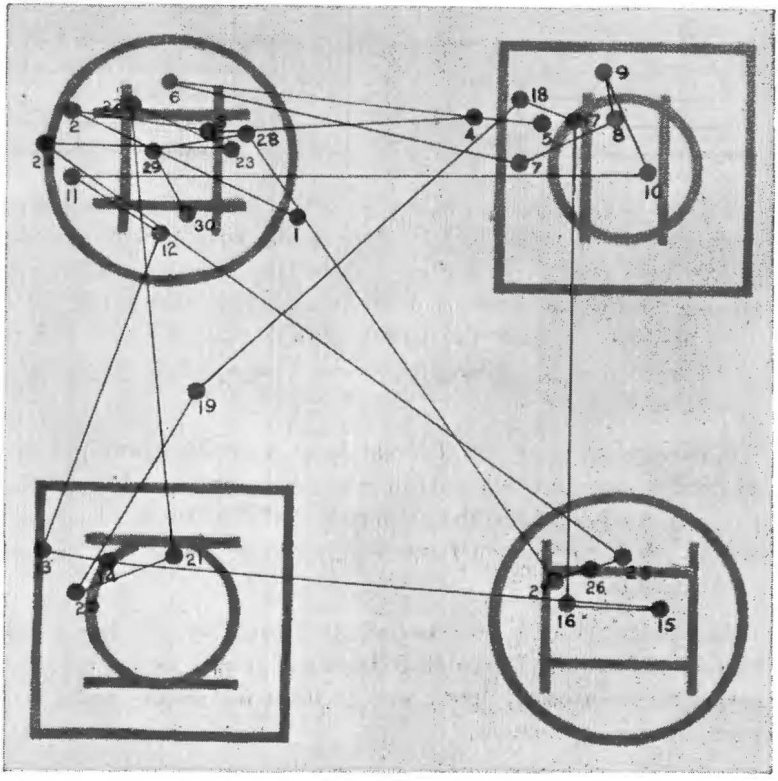

Fig. 5. Ocular Pattern of subject 46, Achievement 7 units.

4. *Low vs. High Achivement:* To conclude whether the ocular patterns of the high achievement group are different from those of low achievement is to analyze the ocular pattern in units of time and achievement.

Table IV. Average Fixation Time Per Unit of Achievement for Subjects of High and Low Achievement

Card	Symbol	1	2	3	4	Total
A	High Ach.	1.19	.81	1.46	1.19	1.17
	Low Ach.	1.93	.93	2.46	4.06	1.93
B	High Ach.	.80	1.21	.92	1.74	1.17
	Low Ach.	1.64	2.07	3.91	2.08	2.18
A & B	High Ach.	1.02	.98	1.22	1.53	1.17
	Low Ach.	1.82	1.52	2.91	2.44	2.05

The above table shows that subjects of low achievement devote nearly twice as much time (2.05 sec.) to acquire one unit of subject matter as do their superior competitors who devote only (1.17 sec.) to achieve a unit of the same type of subject matter.

The greatest margin of difference between those of high and low achievement is in symbol number (4) when appearing in the lower right hand position. The high achievement group spent an average of 1.19 seconds to acquire one unit of symbol (4) while the low achievement group spent an average of 4.06 seconds for every unit correctly reproduced.

From all indications it would seem that position (for symbols more difficult to reproduce) is a greater determiner of the level of achievement for those of low than for those of high achievement. The low achievement group spent an average of 4.06 seconds when symbol (4) appeared in the lower right hand position and only 2.08 seconds when the same symbol appeared in the upper left hand area, while the high achievement group had a ratio of 1.19:1.74 for the same symbols. This difference is much smaller (1.93 to 1.82) for symbol (1), a more familiar symbol when appearing in the two positions. The ratios are 1.19:1.93 and 1.93:1.82 for the high and low achievement groups respectively.

Summary and Conclusions

Based upon the results of this study, it is apparent that both time spent and information gained are greater for symbols presented in certain positions. The differences for both time and achievement are significant for the positions analyzed.

Since the frequency and direction of excursions reveals a preference, it follows that the presentation of subject matter is a vital factor in determining learning efficiency.

Consistently more time is spent by subjects of low attainment for each unit of achievement than by their competitors of high accomplishments. Ocular patterns are affected by the position of symbols, and the character of the observed field as well as by the intellectual achievement of the observer.

The location and sequence of ocular fixations, the excursion distance and direction imply psychological operations which function in terms of retention and have a future reference. Ocular patterns viewed in the light of learning constitute an expression of the discovery of relations which exist or which according to the learner should exist among the components present. Organization

in this sense of the term is no longer an abstract idea, but has meaning in terms of ocular performance implying methods and procedures employed by the learner.

If intelligent guidance of learning presupposes a knowledge of the method employed by the learner, then ocular patterns are likely to provide a valuable criterion for evaluating the learning process and consequently establish a criterion of learning efficiency.

The analysis of ocular performance by means of photography may determine for it the place it shall take among education methods which have contributed in providing a more adequate procedure in the educative process.

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